

CLAIMS

What is claimed is:

1 1. An integrated optical component comprising a monolithic optically-translucent  
2 substrate having a plurality of optics formed therein, including:

3 a receiver optic having a first focal point and configured to receive a  
4 substantial portion of an incoming optical beam and direct the optical beam toward  
5 the first focal point;

6 a transmitter optic having a second focal point and configured to receive light  
7 emitted from a light source directed from the second focal point and direct the light  
8 outward as an outgoing optical beam;

9 a pickoff lens having a third focal point and configured to receive a tracking  
10 portion of the incoming optical beam and direct said tracking portion towards the  
11 third focal point; and

12 a first fold mirror configured to receive the tracking portion of the light beam  
13 and redirect it toward a first predetermined direction.

1 2. The integrated optical component of claim 1, wherein the pickoff lens is  
2 coaxial with the receiving lens such that the first and third focal points are disposed  
3 at different lengths along a common axis.

1 3. The integrated optical component of claim 1, wherein the first fold mirror  
2 comprises a first substrate/air facet defined in a back surface of the monolithic  
3 optically-translucent substrate to which a reflective coating is applied.

1 4. The integrated optical component of claim 2, wherein the pickoff lens  
2 comprises a convex lens formed on a front surface of the monolithic optically-  
3 translucent substrate, further comprising a second fold mirror defined by a second  
4 substrate/air facet defined in the front surface of the monolithic optically-translucent  
5 substrate to which a reflective coating is applied, and further wherein the first fold  
6 mirror is configured to redirect the tracking portion of the light beam through the  
7 monolithic optically-translucent substrate toward the second fold mirror, which in  
8 turn redirects the tracking portion of the light beam toward a second predetermined  
9 direction.

1 5. The integrated optical component of claim 1, wherein the first fold mirror is a  
2 first total internal reflection (TIR) fold mirror comprising a first substrate/air facet  
3 defined in a back surface of the monolithic optically-translucent substrate.

1 6. The integrated optical component of claim 5, wherein the pickoff lens  
2 comprises a convex lens formed on a front surface of the monolithic optically-  
3 translucent substrate, further comprising a second TIR fold mirror defined by a  
4 second substrate/air facet defined in the front surface of the monolithic optically-  
5 translucent substrate, and further wherein the first TIR fold mirror is configured to  
6 redirect the tracking portion of the light beam through the monolithic optically-  
7 translucent substrate toward the second TIR fold mirror, which in turn redirects the  
8 tracking portion of the light beam toward a second predetermined direction.

1 7. The integrated optical component of claim 6, further comprising a mounting  
2 pad disposed on the back surface of the monolithic optically-translucent substrate to  
3 which an optical beam position sensor may be mounted such that the optical beam

4 position sensor receives the tracking portion of the light beam redirected by the  
5 second TIR fold mirror.

1 8. The integrated optical component of claim 1, wherein the monolithic optically-  
2 translucent substrate comprises a plastic.

1 9. The integrated optical component of claim 1, wherein the monolithic optically-  
2 translucent substrate comprises a glass.

1 10. The integrated optical component of claim 1, further including at least one  
2 alignment hole defined in the monolithic optically-translucent substrate and  
3 configured to receive an alignment pin upon assembly of the integrated optical  
4 component to an optical mount.

1 11. The integrated optical component of claim 1, further including at least one  
2 baffle defined in the monolithic optically-translucent substrate proximate to a desired  
3 path along which the tracking portion of the light beam is directed to block unwanted  
4 optical energy from the desired path.

1 12. An integrated optical component comprising a monolithic optically-translucent  
2 substrate in which a plurality of optics are formed, including:  
3 a receiver optic having a first focal point and configured to receive a  
4 substantial portion of an incoming optical beam and direct the optical beam toward  
5 the first focal point;

6 a transmitter optic having a second focal point and configured to receive light  
7 emitted from a light source directed from the second focal point and direct the light  
8 outward as an outgoing optical beam;

9 a total internal reflection (TIR) combiner comprising a plurality of substrate/air  
10 facets defined in a surface of the monolithic optically-translucent substrate, each  
11 substrate/air facet configured to receive a light beam portion and redirect the light  
12 beam portion toward a respective predetermined direction; and

13 a plurality of tracking lenses, each having a respective focal point and  
14 configured to receive a portion of the incoming optical beam and direct said portion  
15 towards its respective focal point; and

16 a plurality of TIR fold mirrors, each configured to receive a respective portion  
17 of the incoming light beam received by a respective tracking lens that is directed  
18 toward that TIR fold mirror and redirect the respective portion of the incoming light  
19 beam towards a respective substrate/facet of the TIR combiner.

1 13. The integrated optical component of claim 12, wherein the plurality of tracking  
2 lenses are radially disposed about the receiving optic at substantially evenly spaced  
3 angles.

1 14. The integrated optical component of claim 12, wherein the TIR combiner is  
2 disposed between the receiving optic and the transmitting optic.

1 15. The apparatus of claim 12, wherein the monolithic optically-translucent  
2 substrate comprises a plastic.

1 16. The apparatus of claim 12, wherein the monolithic optically-translucent  
2 substrate comprises a glass.

1 17. The integrated optical component of claim 12, further comprising a mounting  
2 pad disposed on a surface of the monolithic optically-translucent substrate to which  
3 an optical beam position sensor may be mounted such that the optical beam  
4 position sensor receives the portions of the incoming light beam that are redirected  
5 by the respective substrate/air facets defined in the TIR combiner.

1 18. The integrated optical component of claim 12, further including at least one  
2 alignment hole defined in the monolithic optically-translucent substrate and  
3 configured to receive an alignment pin upon assembly of the integrated optical  
4 component to an optical mount.

1 19. An integrated optical component comprising a monolithic optically-translucent  
2 substrate in which a plurality of optics are formed, including:

3 a receiver optic having a first focal point and configured to receive a  
4 substantial portion of an incoming optical beam and direct the optical beam toward  
5 the first focal point; and

6 a plurality of transmitter optics, each having a respective focal point and  
7 configured to receive light emitted from a respective light source disposed proximate  
8 to the respective focal point and direct the light outward as a respective outgoing  
9 optical beam.

1 20. The integrated optical component of claim 19, wherein the plurality of tracking  
2 transmitter optics are radially disposed about at substantially evenly spaced angles.

1 21. An integrated optical component comprising a monolithic optically-translucent  
2 substrate in which a plurality of optics are formed, including:

3 a receiver optic having a first focal point and configured to receive a  
4 substantial portion of an incoming optical beam and direct the optical beam toward  
5 the first focal point;

6 a plurality of transmitter optics;

7 a combiner comprising a plurality of substrate/air facets defined in a surface  
8 of the monolithic optically-translucent substrate, each substrate/air facet configured  
9 to receive a respective portion of a light beam emitted from a light source and  
10 redirect the light beam portion toward a respective predetermined direction; and

11 a plurality of fold mirrors, each configured to receive a respective light beam  
12 portion and redirect the respective light beam portion towards a respective  
13 transmitter optic,

14 wherein light beam portions exit the plurality of transmitter lenses as a  
15 plurality of substantially collimated transmitted optical signals.  
16

1 22. The integrated optical component of claim 21, wherein the combiner  
2 comprises a total internal reflection (TIR) combiner.

1 23. The integrated optical component of claim 22, wherein each of the fold  
2 mirrors comprises a total internal reflection fold mirror.

1 24. A free space optical (FSO) transceiver comprising:  
2 a housing;

3 a light receiver coupled to the housing;  
4 a light source coupled to the housing;  
5 a monolithic optically-translucent substrate coupled to the housing having a  
6 plurality of optics formed therein, including:  
7 a receiver optic having a first focal point substantially coincident with  
8 an input of the light receiver and configured to receive a substantial portion of  
9 an incoming optical beam and direct the optical beam toward the light  
10 receiver;  
11 a transmitter optic having a second focal point substantially coincident  
12 with a location of the light source and configured to receive light emitted from  
13 the light source and direct the light outward as an outgoing optical beam;  
14 a pickoff lens having a third focal point and configured to receive a  
15 portion of the incoming optical beam and direct said portion towards the third  
16 focal point;  
17 a first total internal reflection (TIR) fold mirror configured to receive the  
18 portion of the light beam received by the pickoff lens and directed towards the  
19 third focal point and redirect this portion of the light beam towards a first  
20 predetermined direction; and  
21 a second TIR fold mirror configured to received the portion of the light  
22 beam redirected by the first TIR fold mirror toward the first predetermined  
23 location and redirect the portion of the light beam toward a second  
24 predetermined direction; and  
25 an optical beam position sensor, operatively coupled to the monolithic  
26 optically-translucent substrate so as to receive the portion of the light beam  
27 redirected by the second TIR fold mirror toward the second predetermined direction.

1 25. The FSO transceiver of claim 24, wherein the optical beam position sensor  
2 comprises a quad cell.

1 26. The FSO transceiver of claim 24, wherein the optical beam position sensor  
2 comprises a charge-coupled device.

1 27. The FSO transceiver of claim 24, wherein the optical beam position sensor  
2 comprises a lateral effect cell.

1 28. The FSO transceiver of claim 24, further comprising:  
2 a positioner having a rigid portion fixedly coupled to a building structure and a  
3 movable portion coupled to the housing so as to enable the positioner to position the  
4 housing; and  
5 a position controller, receiving position data from the optical beam position  
6 sensor and driving the positioner so as to optimize a position of the FSO transceiver  
7 based on the position data.

1 29. A free space optical (FSO) transceiver comprising:  
2 a housing;  
3 a light receiver coupled to the housing;  
4 a light source coupled to the housing;  
5 a monolithic optically-translucent substrate coupled to the housing having a  
6 plurality of optics formed therein, including:



7 a receiver optic having a first focal point and configured to receive a  
8 substantial portion of an incoming optical beam and direct the optical beam  
9 toward the first focal point;

10 a transmitter optic having a second focal point and configured to  
11 receive light emitted from a light source directed from the second focal point  
12 and direct the light outward as an outgoing optical beam;

13 a total internal reflection (TIR) combiner comprising a plurality of  
14 substrate/air facets defined in a surface of the monolithic optically-translucent  
15 substrate, each substrate/air facet configured to receive a light beam portion  
16 and redirect the light beam portion toward a respective predetermined  
17 direction; and

18 a plurality of tracking lenses, each having a respective focal point and  
19 configured to receive a portion of the incoming optical beam and direct said  
20 portion towards its respective focal point; and

21 a plurality of TIR fold mirrors, each configured to receive a respective  
22 portion of the incoming light beam received by a respective tracking lens that  
23 is directed toward that TIR fold mirror and redirect the respective portion of  
24 the incoming light beam towards a respective substrate/facet of the TIR  
25 combiner; and

26 an optical beam position sensor, operatively coupled to the monolithic  
27 optically-translucent substrate proximate to the TIR combiner so as to received the  
28 respective portions of the light beam redirected by the TIR combiner toward the  
29 respective predetermined directions.

1 30. The FSO transceiver of claim 29, wherein the optical beam position sensor  
2 comprises a quad cell.

1 31. The FSO transceiver of claim 29, wherein the optical beam position sensor  
2 comprises a charge-coupled device.

1 32. The FSO transceiver of claim 29, wherein the optical beam position sensor  
2 comprises a lateral effect cell.

1 33. The FSO transceiver of claim 29, further comprising:  
2 a positioner having a rigid portion fixedly coupled to a building structure and a  
3 movable portion coupled to the housing so as to enable the positioner to position the  
4 housing; and  
5 a position controller, receiving position data from the optical beam position  
6 sensor and driving the positioner so as to optimize a position of the FSO transceiver  
7 based on the position data.

1 34. A method for controlling a position of a free space optical (FSO) transceiver,  
2 comprising:  
3 directing a portion of an incoming optical signal received by a monolithic  
4 integrated optic component disposed in the FSO transceiver towards a optical beam  
5 position sensor using a plurality of optics defined in the integrated optic component;  
6 determining a positional error based on data provided by the optical beam  
7 position sensor; and  
8 adjusting a position of the FSO transceiver based on the positional error.

1 35. The method of claim 34, wherein the integrated optic component includes a  
2 pickoff lens and a total internal reflection (TIR) fold mirror, and wherein directing the

3 portion of the incoming optical signal toward the optical beam position sensor  
4 comprises:

5 receiving the portion of the incoming optical signal with the pickoff lens and  
6 directing it towards the TIR fold mirror; and

7 redirecting the portion of the optical signal with the TIR fold mirror towards the  
8 optical beam position sensor.

1 36. The method of claim 34, wherein the integrated optic component includes a  
2 pickoff lens and first and second total internal reflection (TIR) fold mirrors, and  
3 wherein directing the portion of the incoming optical signal toward the optical beam  
4 position sensor comprises:

5 receiving the portion of the incoming optical signal with the pickoff lens and  
6 directing it towards the first TIR fold mirror;

7 redirecting the portion of the optical signal with the first TIR fold mirror  
8 towards the second TIR fold mirror; and

9 redirecting the portion of the optical signal with the second TIR fold mirror  
10 towards the optical beam position sensor.

1 37. A method for controlling a position of a free space optical (FSO) transceiver,  
2 comprising:

3 directing respective portions of an incoming optical signal received by a  
4 monolithic integrated optic component disposed in the FSO transceiver towards a  
5 total internal reflection (TIR) combiner defined in the integrated optic component  
6 using a plurality of optics defined in the integrated optic component;

7 redirecting the respective portions of the incoming optical signal via the TIR  
8 combiner toward a optical beam position sensor;

9 determining a positional error based on data provided by the optical beam  
10 position sensor; and  
11 adjusting a position of the FSO transceiver based on the positional error.

1 38. The method of claim 37, wherein the integrated optic component includes a  
2 plurality of tracking lenses, each having a corresponding TIR fold mirror disposed in  
3 proximity thereto; and wherein directing the respective portions of the incoming  
4 optical signal toward the TIR combiner comprises:

5 receiving the respective portions of the incoming optical signal with the  
6 plurality of tracking lenses, each tracking lens directing the respective portion of light  
7 that it receives towards its corresponding TIR fold mirror; and

8 for each TIR fold mirror, redirecting the portion of the optical signal directed  
9 towards that TIR fold mirror towards a respective facet defined in the TIR combiner.

1 39. A method for controlling a position of a first free space optical (FSO)  
2 transceiver, comprising:

3 establishing a communication link with a second FSO transceiver;

4 directing a portion of a first incoming optical signal received by a first  
5 integrated optic component disposed in the second FSO transceiver towards a first  
6 optical beam position sensor using a plurality of optics defined in the integrated optic  
7 component;

8 transmitting position data obtained by the first optical beam position sensor to  
9 the first FSO transceiver;

10 determining a positional error based on the position data; and

11 adjusting a position of the first FSO transceiver based on the positional error.

1 40. The method of claim 39, further comprising:  
2 directing a portion of a second incoming optical signal received by a second  
3 integrated optic component disposed in the first FSO transceiver towards a second  
4 optical beam position sensor using a plurality of optics defined in the second  
5 integrated optic component;  
6 obtaining position data from the second light beam position;  
7 determining the positional error based on a combination of position data  
8 obtained from the first and second optical beam position sensors; and  
9 adjusting a position of the first FSO transceiver based on the positional error.

1 41. A method for controlling a position of a first free space optical (FSO)  
2 transceiver, comprising:  
3 establishing a communication link with a second FSO transceiver;  
4 directing respective portions of a first incoming optical signal received by a  
5 first integrated optic component disposed in the second FSO transceiver towards a  
6 first total internal reflection (TIR) combiner defined in the integrated optic component  
7 using a plurality of optics defined in the integrated optic component;  
8 redirecting the respective portions of the first incoming optical signal via the  
9 first TIR combiner toward a first optical beam position sensor;  
10 transmitting position data obtained by the first optical beam position sensor to  
11 the first FSO transceiver;  
12 determining a positional error based on the position data; and  
13 adjusting a position of the first FSO transceiver based on the positional error.

1 42. The method of claim 41, further comprising:

2 directing a portion of a second incoming optical signal received by a second  
3 integrated optic component disposed in the first FSO transceiver towards a second  
4 optical beam position sensor using a plurality of optics defined in the second  
5 integrated optic component;

6 directing respective portions of a second incoming optical signal received by  
7 a second integrated optic component disposed in the first FSO transceiver towards  
8 a second total internal reflection (TIR) combiner defined in the second integrated  
9 optic component using a plurality of optics defined in the second integrated optic  
10 component;

11 redirecting the respective portions of the second incoming optical signal via  
12 the second TIR combiner toward a second optical beam position sensor;

13 obtaining position data from the second light beam position;

14 determining the positional error based on a combination of position data  
15 obtained from the first and second optical beam position sensors; and

16 adjusting a position of the first FSO transceiver based on the positional error.

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